2021 43rd Annual International Conference of the
IEEE Engineering in Medicine & Biology Society (EMBC)
Oct 31 - Nov 4, 2021. Virtual Conference

Voice Interactive Control System for Surgical Assistant Robot in Clock Position

Yuta Egi, Toshikazu Kawai, *Member, IEEE*, Atsushi Nishikawa,
Yuji Nishizawa, and Tatsuo Nakamura

***Abstract*— A new voice interactive control system to drive a surgical assistant manipulator in clock position performed by a surgeon in a sterilized area has developed. The system was constructed using speech recognition engine Julius and forceps manipulator, and the tracking performance was evaluated.**

I. Purpose

By integrating locally operated surgical assistant robots [1-2] in a sterilized area, a surgeon can perform safe and accurate robotically assisted laparoscopic surgery. It is important that the manipulation of surgical assistant robots is intuitive and easy to perform when concentrating on a laparoscopic view. Therefore, it is necessary for the surgeon to operate a hands-free device controlling the robot. Although voice control provides easy manipulation [1], on/off command to drive for individual axis direction is one-way communication. We propose a new voice interactive control system to drive the assistant manipulator for coarse and fine position.

II. Methods

A voice interactive control system including both of coarse drive mode in clock position and fine drive mode in a slight movement after confirmation of the correct position from a surgeon was developed. The coarse mode is driven by 30 deg. for 12 directions of clock position after recognition of a word such as "five". The fine mode is driven by a slight angle for the same rotational direction after recognition of a word such as "a little bit". The on/off drive mode in individual axis direction is also included in the system.

The proposed system consists of a microphone, a speaker, a limited word dictionary applied to speech recognition engine Julius [3], and forceps assistant manipulator LODEM. The control procedure is as follows. (1) Input a speech of the surgeon to Julius. (2) Send the recognized words to the control program using the module mode of Julius. (3) Drive LODEM based on the registered words. (4) Output a speech from the system whether the driven position is correct.

*Research supported in part by JSPS Kakenhi Grant Number JP21K03986.

Y. Egi and T. Kawai are with the Major in Robotics & Design, Osaka Institute of Technology, Osaka, 530-8568 Japan (corresponding author to provide e-mail: sdyp98@gmail.com).

A. Nishikawa is with the Graduate School of Engineering Science, Osaka University, Toyonaka, 560-8531 Japan.

Y. Nishizawa is with the Department of Colorectal Surgery, National Cancer Center Hospital East, Kashiwa, 277-8577 Japan.

T. Nakamura is with the Graduate School of Medicine, Kyoto University, Kyoto, 606-8507 Japan.

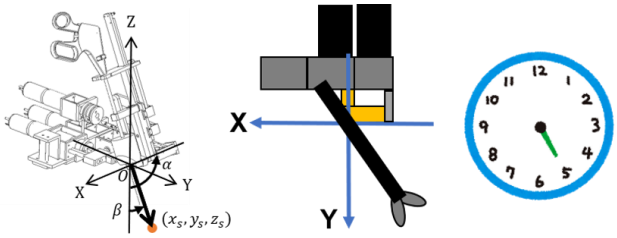
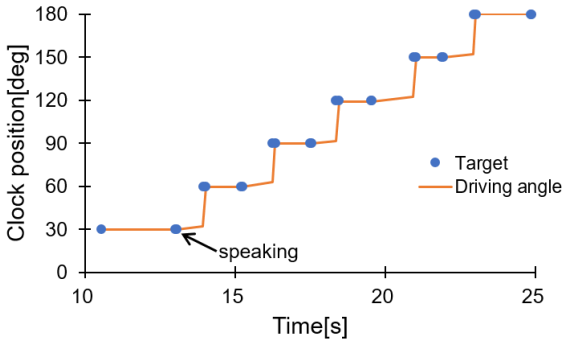


Figure 1. Clock position at the tip of the forceps using LODEM



Target angles calculated based on speeches and driving angles using LODEM in the coarse drive mode was measured. The clock position "twelve" at 0 deg. is defined as the tip of the forceps on a negative Y axis in horizontal XY plane shown in Fig. 1. The clockwise angle is about Z-axis.

III. Results and Discussion

Measurement results are shown in Fig. 2. Driving angles were tracked to target angles calculated after recognition of words indicating times. Time delays to recognize words were occurred. The voice control system with a coarse drive mode in clock position was confirmed. Future work includes expanding the clock position on the endoscopic view, and applying simulated surgery.

References

[1] A. A. Gumbs, F. Crovari, C. Vidal, P. Henri, and B. Gayet, "Modified robotic lightweight endoscope (ViKY) validation in vivo in a porcine model," *Surgical Innovation*, vol. 14, no. 4, 2007, pp. 261-264.

[2] S. Fukui, T. Kawai, et al., "Locally operated assistant manipulators with selectable connection system for robotically assisted laparoscopic solo surgery," *IJCARS,* vol.16, no. 4, 2021, pp.683–693.

[3] A. Lee and T. Kawahara, "Recent Development of Open-Source Speech Recognition Engine Julius," *in Proc. APSIPA-ASC*, 2009, pp.131-137.